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SUBJECT: PROCEDURE FOR THE RECOVERY AND PURIFICATION OF STRONTIUM FROM THE ORNL-RaLa VERSENE WASTE

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PROCEDURE FOR THE RECOVERY AND PURIFICATION OF STRONTIUM FROM THE ORNL-RaLa VERSENE WASTE

The estimated composition of the Versene waste solution from a 40,000 curie Ba^{140} run is as follows:

$Sr^{89, 90}$ - 3400 curies ≈0.8 gm

Ba^{140} - 800 curies

$Ce^{141,144}$ - 500 curies

Other activities <100 Curies

1 Mole of Versene

4 Moles of Sodium Hydroxide

1.6 Moles of Nitric Acid

Total Volume = ~50 Liters

The procedure listed in the following sections will recover the strontium in a yield <97% and the product will contain ~5 x 10^{-4}% and <0.1% of the original amounts of Ce and Ba respectively.

It is recommended that the Versene waste solution be processed as soon as possible after the RaLa run since it is known that Versene is decomposed by radiation. Calculations show that 10-20% of the Versene will be decomposed if a solution of the above composition stands for four (4) days. The decomposition of the Versene may cause the precipitation of a portion of the cations. Therefore, as an extra precaution, fresh Versene is added to

the solution just prior to processing to ensure the solubility of all the cations.

In the development experiments the bulk of the rare earths were separated from the strontium at the time the latter was adsorbed on the resin column from the waste solution. The rare earths are very strongly complexed by the Versene and are not adsorbed. If a large fraction of the Versene has been decomposed by radiation, however, this separation may not be complete. Consequently, an elution with sodium citrate at pH 3.5 is carried out to ensure the elimination of the rare earths.

Precipitation of strontium nitrate from 85% nitric acid is recommended as a final step to eliminate the last traces of corrosion products, organic impurities, sodium, and rare earths. Laboratory experiments showed that the solubility of strontium in 85% nitric acid is 3 $\pm$1 mg/liter. The strontium loss from the precipitation of 800 mg of strontium from 4.0 liters of 85% nitric acid, using an "M" sintered glass filter, was approximately 1.0%. This experiment indicates that the strontium nitrate crystals are large enough to be caught quantitatively on the tantalum process filter. The fuming nitric acid step is not possible at present, however, due to the lack of a suitable carrier to receive the product solution from the precipitation tank.

The stepwise operating procedure is listed on the following pages and a flow sheet is shown in Figures I, II, and III.

OPERATING PROCEDURE

Resin Preparation:

(a) Clean and activate 4.0 liters of Dowex-50 resin according to the regular ORNL-RaLa procedure. (See ORNL-Central Files Report 51-9-83.)

(b) Measure 3.1L of settled Na^+ form resin and slurry into the process column.

Feed Make Up:

(a) Add 1 liter of 0.25 M, pH 11, sodium Versenate (stock solution) and 1.6 liters of 1.0 M sodium hydroxide to the RaLa strontium Versenate waste solution and evaporate the combined solution to 14.0L. Transfer the solution to the ion exchange feed tank.

(b) Wash the tank with 6.0L of water added through the slinger ring and transfer continuously to the feed tank.

(c) Adjust the combined feed solution to pH 4.0 - 4.3 by adding 70% nitric acid (approximately 160 ml).

ION EXCHANGE PURIFICATION

	SOLUTION	VOLUME (Liters)	FLOW RATE (ml/min.)
(a)	Strontium Adsorption (Strontium Versenate Feed) pH 4.0 - 4.3	20.0	500-600
(b)	Feed Tank Wash Water	2.0	500-600

The following solutions are passed through the column from the elution tank:

(c)	Rare Earth Elution 0.5M Sodium Citrate pH 3.5 ±0.05	10.0	280

Make up the sodium citrate solution by adding sodium hydroxide to citric acid.

(d)	Water Wash	2.5 7.5	280 500
(e)	Strontium Elution 0.2M Sodium Citrate pH 9.0 ±0.3	12.0	225
	Water Wash	2.0	225

The strontium citrate eluant is combined with its water wash and saved for further processing (See Part (j)).

(f)	Barium Elution 0.25M Sodium Versenate pH 11, Stock Solution	4.0	350

SOLUTION	VOLUME (Liters)	FLOW RATE (ml/min.)
(g) Water Wash	2.5L 7.5L	350 500
(h) Column Clean Up		
2.0 M HNO_3	3.0L	350
9.0 M HNO_3	13.0L	60
(i) Water Wash	10 L	350
(j) Strontium Adsorption	19.6	500

Return the strontium citrate solution (See Part (e)) to the feed tank and follow with a 5.0L tank wash. Add 600 ml of 70% nitric acid to lower the pH to <1.0. Sparge 10 minutes and pass the solution through the column. The strontium is adsorbed while the citrate passes through to the waste tank.

(k) Feed Tank Wash Water	2.0	500

The following solutions are passed through the column from the elution tank.

(l) Water Wash	8.0	500
(m) Sodium Elution	10.0	440
1.0M HCl		
(n) Water Wash	10.0	440
(o) Strontium Product Elution	6.0	350
9M HNO_3	10.0	60

FUMING NITRIC ACID PRECIPITATION

(a) Evaporate the nitric acid column product eluate to 1.0L and cool to 25°C.

(b) Add 3 liters of 90-92% nitric acid, cool to 25°C, agitate 15 minutes, and filter.

(c) Wash the precipitated Sr $(NO_3)_2$ with one liter of 85% nitric acid and filter.

(d) Dissolve the pure strontium product in 0.5 liter of water.

FIGURE I - PART I

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FLOWSHEET: RECOVERY AND PURIFICATION OF STRONTIUM FROM THE ORNL-Rala VERSENE WASTE

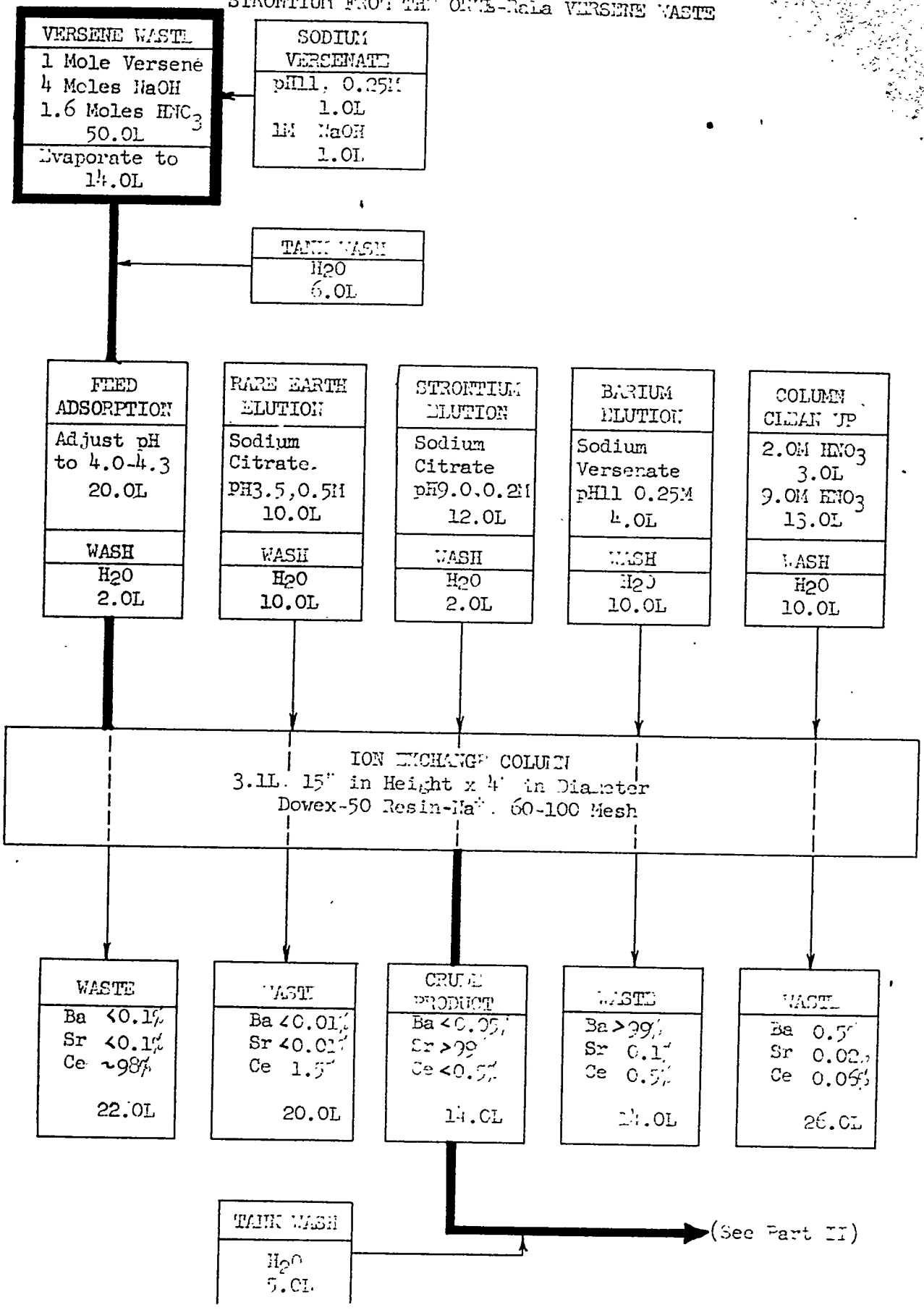

FIGURE III - PART III

DWG. 1350

FLOWSHEET: RECOVERY AND PURIFICATION OF STRONTIUM FROM THE ORNL-Pala MINERAL ACT

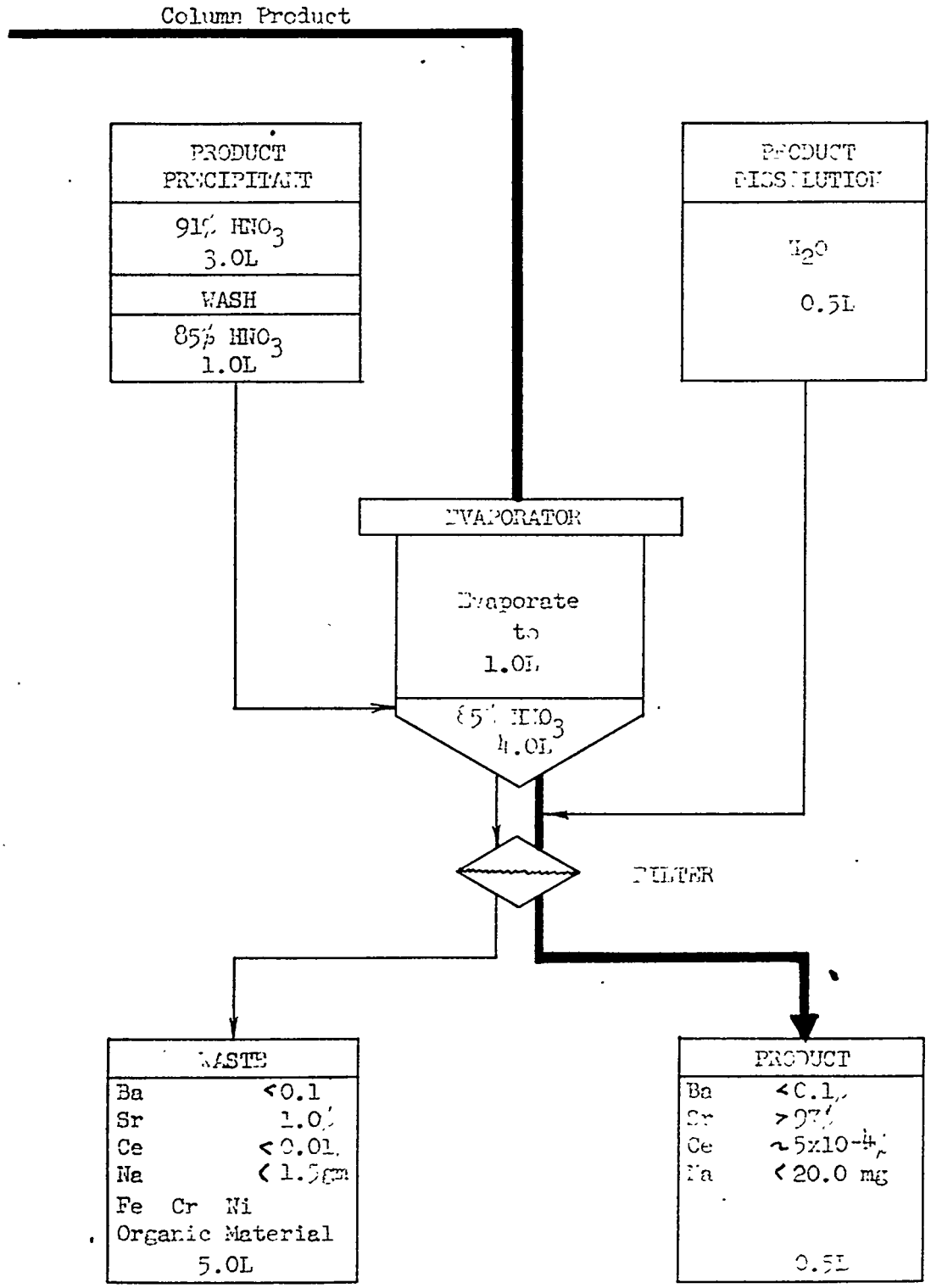

FIGURE II - PART II

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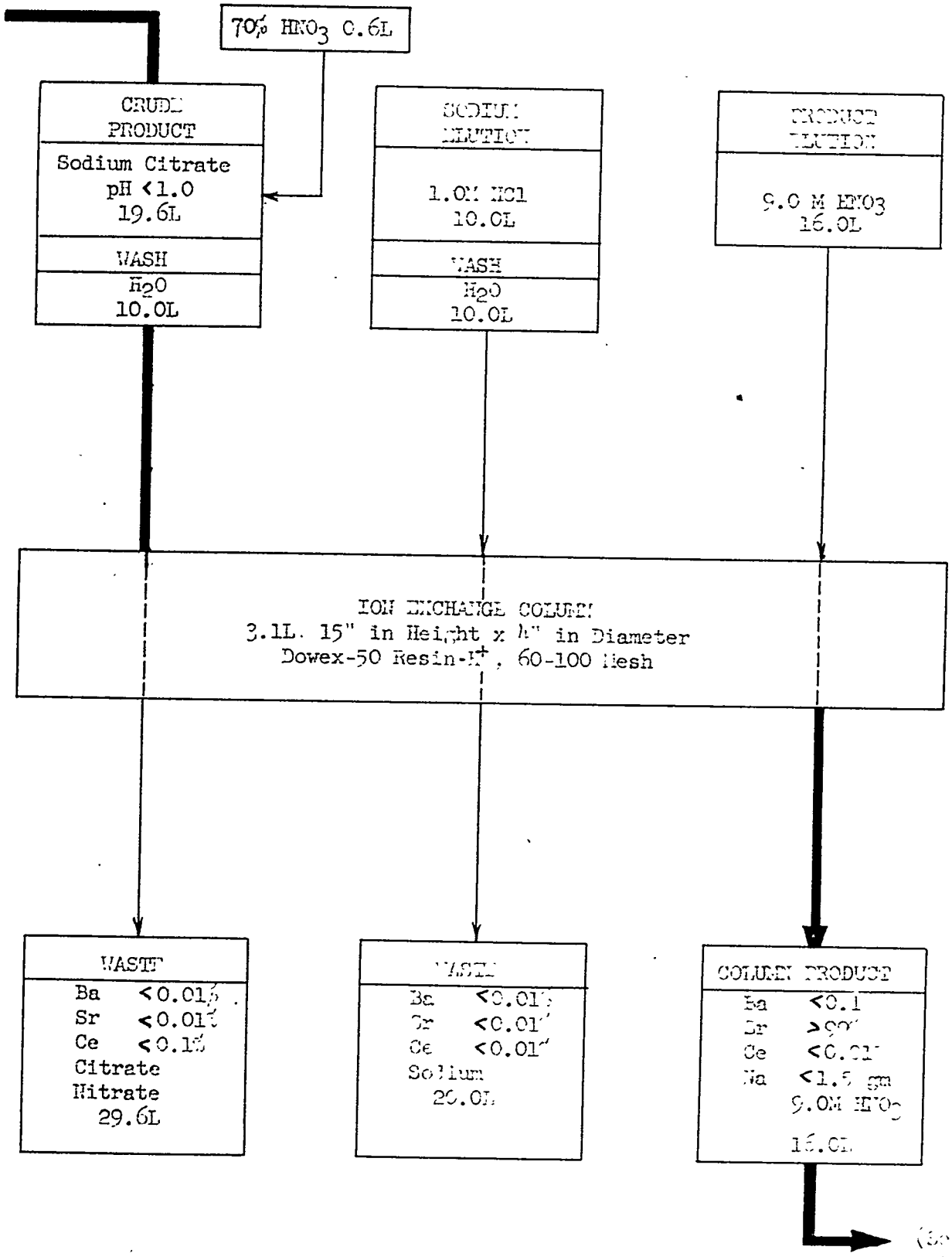
FLOWSHEET: RECOVERY AND PURIFICATION OF STRONTIUM FROM THE ORNL-Rale VERSENE WASTE



(See Part II)